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Novel Superconductivity in Electron-Doped Layered Li-HfNCl

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Layered band insulator β-HfNCl having a gap $E_g \sim 4$ eV becomes superconducting with a relatively high T_c of 25.5 K by Li intercalation, $Li_{0.48}(THF)_yHfNCl$ (Li-HfNCl). In order to investigate why such a high T_c is realized in this system, dc-magnetic susceptibility and NMR measurements were carried out on Li-$Hf^{14}NCl$ and Li-$Hf^{15}NCl$. For the magnetic field (H) applied perpendicular to the basal-plane above 10 kOe, we found that diamagnetic moments appear at temperature as high as $\sim 2 \times T_c$, with increasing H. Together with the Li-NMR results, Li-HfNCl system is a new calass of the quasi-two-dimensional superconductor. The present studies also revealed that (a) the Fermi level density of states is small, $N^*(E_F) \sim 0.25$ states/(eV spin f.u.), (b) mass enhancement is negligible, $\tilde{\gamma} \sim 1$, (c) electron-phonon coupling is weak, $\lambda_{ep} \ll 1$, (d) exchange enhancement is negligible, $1/(1+F_0^a) \sim 1$, and (e) electronic density parameter is large, $r_s^{2D} \sim 10.3$ (i.e., low-carrier-density). It is difficult to explain the origin of the high T_c in terms of the conventional phonon (BCS) mechanism of superconductivity. A possibility of charge-fluctuation, i.e., a long-range Coulomb interaction, mechanism of superconductivity will be discussed, including the nitrogen isotope effect.